This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

FORESTRY
SD
12
M5
H6
#2

BUHR B

a39015 00018295 9b

Gaylord
SPEEDY BINDER
Syracuse, N. Y.
Stockton, Calif.

Forestry
SD
12
.M5
H6

Fib 38.1

SD
12
M5
H6
#2

MICHIGAN
STATE HIGHWAY DEPARTMENT
LANSING

BULLETIN NO. 2.
SECOND EDITION.

GRAVEL ROADS

BY

FRANK F. ROGERS, C. E.,
State Highway Commissioner.

JULY, 1913.

LANSING, MICHIGAN
WYNKOOP HALLENBECK CRAWFORD CO., STATE PRINTERS
1913

ORESTRY DEPARTMENT

MICHIGAN
STATE HIGHWAY DEPARTMENT
LANSING

BULLETIN NO. 2.

SECOND EDITION.

GRAVEL ROADS

BY

FRANK F. ROGERS, C. E.,
STATE HIGHWAY COMMISSIONER.

JULY, 1913.

LANSING, MICHIGAN
WYNKOOP HALLENBECK CRAWFORD CO., STATE PRINTERS
1913

GRAVEL ROADS.

A well graded and well drained earth road is necessary for the foundation of any kind of an improved road; therefore, money expended on such work is not lost even though it be several years before the road receives a hard surface. In building any good road, the first essentials are a careful survey and suitable plans. As most of the Michigan roads that will be graveled are old roads now in use, and which have been in use for many years, there is but little opportunity to make new locations. However, when new locations are made, as they still are in the newer and sparsely settled counties, the work should be done with the same regard for easy grades, low cost of construction and fitness of roadbed as would characterize a railroad survey. Due prominence should be given to directness, but it should be remembered that the primary object of section lines *is not* to define the center lines of highways, that the distance around a hill may not be much greater than the distance over it, and that slight curves increase the length of a road but little. Sometimes the cost of a new right of way around a bad hill would not be so much as the cost of cutting the hill down to a reasonable grade.

What has been said about new surveys applies with equal force to resurveys, except that old roads can seldom be changed unless the reasons for so doing are very strong. Permanent buildings, improved grounds, beautiful shade trees and other improvements become fixtures along old roads that make changes a hardship to the owners, who frequently, and often justly, strenuously oppose any suggestion of a new location. Nevertheless changes should be made where little damage would result, to avoid bad hills, bad swamps, sinking bogs, expensive stream crossings and sometimes to shorten the road.

On old roads it is best to set the stakes along the sides, one row on each side parallel to the center line, and preferably 20 or 25 feet therefrom, so as to place them on the outer margin of the ditches or gutters where they will not be destroyed by ordinary traffic, nor so easily by grading teams.

The plans should show: (a) the center cuts and fills; (b) the depth of each ditch or gutter from the hub stake adjacent thereto and (c) the vertical distance, up or down, from each side stake to the established center grade. Nothing less complete is satisfactory, for, in most cases, the work of grading is placed in charge of a highway commissioner or his foreman without the assistance of an engineer.

Grades.

In some parts of the State the most troublesome question to consider is that of grades. On State reward roads the law requires that the steepest incline shall not exceed six per cent, meaning a rise of six feet in each one hundred feet of length except where found impracticable and a steeper grade is recommended after examination by the

State Highway Commissioner. It is desirable to keep all grades on heavily traveled roads below six per cent, even down to three per cent or less, where the cost of grading is not burdensome. However, long stretches of unbroken grade are objectionable, being more expensive to maintain than roads that are slightly undulating. Surveyors, who insist on establishing such grades, do their clients a two-fold injury; they unnecessarily increase both the cost of construction and the cost of maintenance. Grades that more nearly follow the lay of the land, using vertical curves at change points, make lines that appear more graceful, and when they are not steep enough to limit the size of loads no valid objection to them can be raised.

To haul a load on a good level gravel road surface, requires a tractive force equal to about one-thirtieth of the weight of the load. To this must be added twenty pounds per ton for each added per cent of incline. Thus, it requires nearly double the power used on the level to haul a given load up a three per cent grade and nearly three times the power to haul the same load up a six per cent grade.

It is estimated that horses can exert one-tenth of their weight as tractive power on continuous work and remain in good condition, but they can readily exert themselves for brief periods of time to two, three and even four times their average daily working capacity. With this in view, making ample allowance for the fatigue of the team due to raising its own weight up the incline, it will be seen that short stretches of undulating grades, none of which exceed six per cent, will not lessen the capacity of a road.

Grading.

The cost of grading depends upon the kind and amount of earth that must be handled and the distance it has to be moved. Where old roads have been regraded for the purpose of building State reward roads, the cost has usually run from $200 to $400 a mile—$300 being a fair average. A few hilly roads have been graded at a cost of more than $2,000 a mile.

Tools Required.

For rather low turnpikes no tool is so efficient as the road grader in skillful hands. For turnpikes with deep ditches, the flat, or Doan scraper, is excellent. This tool is not intended to move earth far but spreads it evenly over the road when rightly handled.

The drag scraper is good for hauls up to 150 feet. Between that distance and 700 feet, wheel scrapers are best; but to use them economically there should be enough scrapers working, unless moving soft sand, to keep a snatch team busy, and where the soil is heavy another team on the plow. For hauls longer than 700 feet it is cheaper to use wagons.

Drainage.

In most soils, sufficient drainage is provided by building the ordinary turnpike with side ditches or gutters just large enough to provide for the free flow of water that naturally comes to the road. In clay soils, the bottoms of the side ditches should be not less than two feet below the crown of the road, unless supplemented by tile drains. Especial pains must be taken to make sure that the ditches have free outlets.

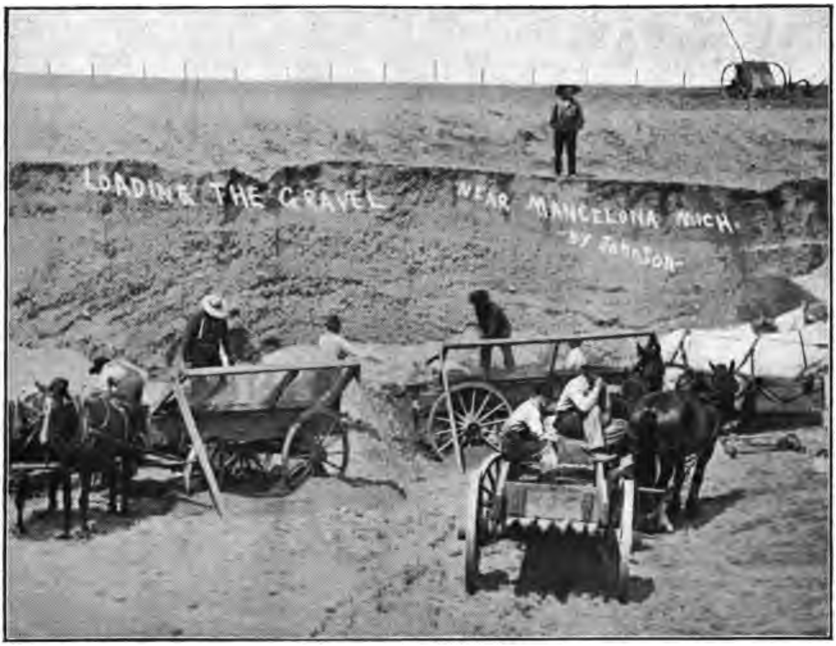
LOADING THE GRAVEL NEAR MANCELONA MICH.
BY JOHNSON

FIG. 4.
Wagon screening device in use near Mancelona, Antrim Co., Mich.

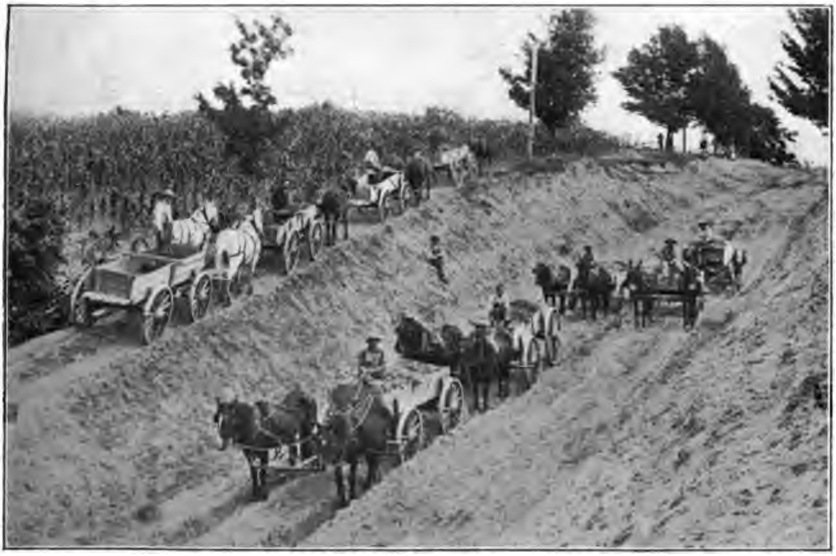

FIG. 5.
Grading scene in Cedar Creek Township, Wexford Co.

Tile drains are a necessity in all springy soils. A four inch land tile laid along the upper side of the road to cut off the spring water before it reaches the road bed will usually prove sufficient. A line of tile can be placed on the other side later if found necessary. It is always advisable to cover the tile to a depth of six inches or more with gravel or cinders, and in very wet soils the drainage will be facilitated by filling the entire trench with some porous material.

In clay soils trenches should be cut through the shoulders described in the next paragraph, making outlets into the side ditches for water that may collect in the gravel bed during construction, and later before the surface becomes hard and water-proof. Such trenches should be eight inches or more in width and slightly deeper than the gravel bed. They should be placed at all low points in the grade and not farther than one hundred feet apart in retentive soils and filled with coarse gravel when the first layer of gravel is put on.

Gravel Bed and Shoulders.

After the rough grading and draining above described have been completed, the gravel bed should be formed in the central part of the road grade by placing shoulders of firm earth on each side and far enough apart to retain the proposed width of gravel, which the law (Section 16, Chapter II, Act 283, Laws of 1909, as amended) provides shall be not less than nine feet wide nor less than six inches in depth. It may, however, be such greater width as the commissioner may specify, and as deep as twelve inches if necessary, but, where any greater depth than six inches is used, the gravel should be put on in two or more layers as herein described.

Where the present road grade is as high or higher than the finished road should be, the shoulders are best formed by scraping earth from the center to each side with the four wheeled grader. But first the road should be leveled by driving the grader back and forth on the center of the turnpike, with the blade set square across, so as to cut off the high places and deposit the earth in the hollows, using the grader as a planing tool. A double row of pickets set one foot farther out on each side than the margins of the gravel bed, so as to clear the hubs and whiffletrees, is a convenient method of staking out the grader work.

If the old road grade is much too low, it is usually cheaper to regrade and form a rather flat turnpike before beginning to form the shoulders. But should the old road bed be about the right height for sub-grade, shoulders may be formed by bringing up earth from the sides with the grader, provided it can be spared from the gutters and ditches. If not, earth should be brought with scrapers or wagons from other places where it can be spared. Many places will be found where the center can be notched out, leaving the undisturbed sides for shoulders, using the earth thus obtained to build up shoulders on slightly lower ground.

The shoulders thus formed should extend to the side ditches or gutters with the same grade and curvature as required for the finished road, viz.: an average rise of one inch for each foot of distance from the inner edge of the ditches or gutters to the center line of road. Thus, a 20 foot roadway would have a 10 inch crown and a 24 foot roadway a 12 inch crown.

After the machine work above described has been completed, lines should be set up on the margins of the gravel bed and enough hand trimming done with mattocks and shovels to bring the gravel bed to the exact subgrade, giving it the same width and curvature as required for the finished road. Gravel is too expensive a material with which to fill hollows, for they can be filled with earth from the shoulders for less money than gravel can be shoveled into wagons at the pit, and every high point protruding into the gravel means a defective place in the finished road. In no case should gravel be applied before the grading is completed.

Graveling.

Next to proper drainage, the most important thing in building gravel roads is to secure a good quality of gravel. Authorities have differed as to the requirements of suitable road gravels, most of them in my opinion, placing too much stress on the immediate packing qualities. Indeed, the average township commissioner and farmers generally have become so imbued with the idea that it is necessary to use a gravel that will pack quickly that they have almost lost sight of the fact that the only thing which makes a gravel road better than an earth road is the pebbles, real stones, that it contains and is dependent upon to bear up traffic and resist wear.

The most common material sought after for the binder in gravel roads is clay. But, considering all kinds of weather, it is probably the poorest cementing material we have. If present, much in excess of 10 percent of the mass, it will make mud whenever there is a prolonged wet spell, and especially when frost is coming out of the ground in the spring. Ideal clay gravels contain only enough clay to coat the pebbles, with no free lumps. Such gravels are excellent for the first layer on sandy soils, but sand gravels are much better for the first layer on clay and loamy soils.

Gravels that come from the pit with the pebbles cemented together, even though they contain no clay, will recement in the road and become harder than they were in the pit. Tests of specimens of this kind always show that there is much lime present and usually some iron, both of which are excellent cementing materials. Briefly, the experience of the State Highway Department warrants the statement that there are few, if any, bank gravels in Michigan that do not contain enough limestone and other soft pebbles which grind up under traffic to furnish sufficient binder to cause them to consolidate in a few months time, if separated from the surplus sand and earth, and properly treated after applying to the road.

In accordance with these suggestions, gravels are considered valuable for road purposes, in the following order:

(1) Almost in direct proportion to the percentage of pebbles constituting the mass.

(2) In direct proportion to the value as road metal of the rock fragments constituting the pebbles.

(3) In direct proportion to the value as a cementing material under all conditions of weather, of the finer particles of earthy matter constituting the filler or binder.

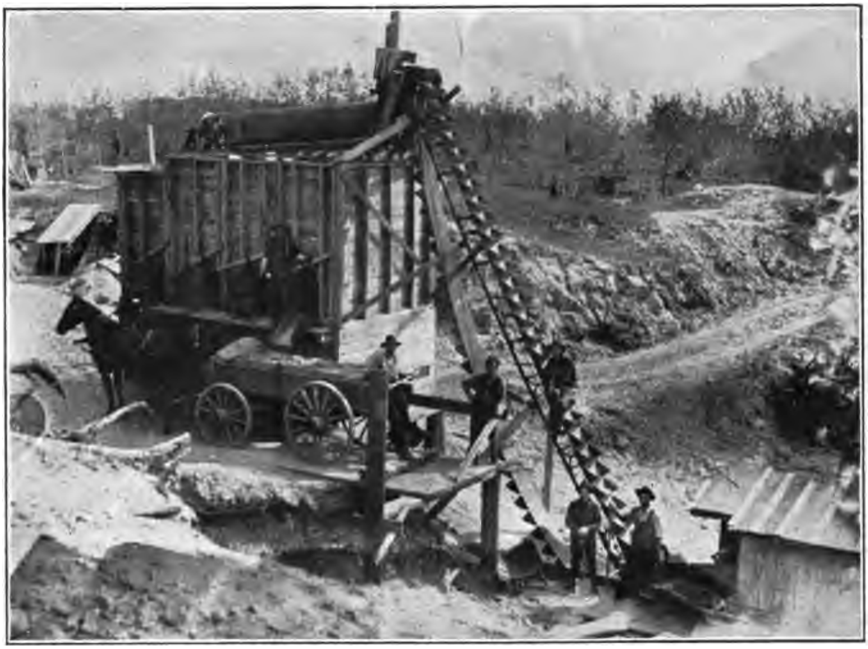

FIG. 6.

Revolving gravel screen with ordinary bucket elevator.

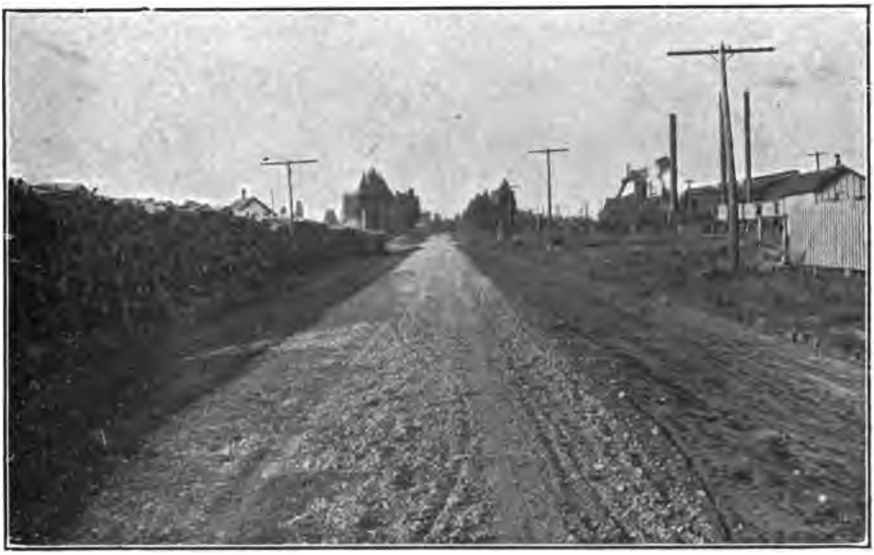

FIG. 7.

Screened gravel road, Mancelona township, Antrim Co., Mich. Partly compacted. This gravel is the product of the screening device shown in Figs. 1 and 4.

Testing Gravel.

Conforming to these principles, the Michigan specifications require that at least 60 per cent by weight of the gravel shall be pebbles above 1-8 inch in size, with no pebbles in the bottom layer that will not pass through a 2½ inch screen, and in the top layer that will not pass through a 1½ inch screen, and that not more than 20 per cent of the mass, much less if possible, shall be clay uniformly mixed and having no free lumps.

A testing screen is easily made by tacking a piece of screen wire of 1-8 inch mesh to a little box one foot square and three inches deep to form the bottom. To avoid figuring in percentages five pounds of pit-run gravel should be weighed out and screened. Three pounds of pebbles out of five would show 60 per cent pebbles; 3½ pounds 70 per cent pebbles; 4 pounds, 80 per cent pebbles, etc.

Screening Gravel.

Many devices are used for screening, ranging from the ordinary mason's hand screen to power driven elevators with rotary screen attached which deliver the graded pebbles into different pockets of elevated bins.

Hand screening with the ordinary mason's screen at Mancelona cost, on the average, about 44 cents per cubic yard for the screened product when shoveled into the wagons. About one-third of the material handled was waste. The wagon screen shown in Figs. No. 1 and 4 has reduced the screening cost to about one-half the above amount. This screen is 3 feet wide and the length of a dump wagon, usually 9 feet. The frame is made of 2 inch by 4 inch scantling with two cross braces of the same material. The frame is covered with screen wire of a size, usually ¼ inch to ⅓ inch mesh, required to give a satisfactory product. The angle at which the screeen is set will vary the product to a considerable extent. The lower edge of the screen is provided with hooks to hang on to the side boards of the wagon, and the screen is supported at the desired angle by posts bolted to the upper end of the frame, or as in later screens, the posts fit in iron hoops attached to the upper side of the screen. This device is quite popular in Antrim and Kalkaska counties.

Some gravel is partially screened when loaded with drag scrapers by allowing it to slide over a chute screen placed on an incline between the dumping platform and the wagon. This screening costs less than it does to shovel the gravel into wagons by hand, but it is not very thorough and cannot be recommended except where the filler is fine dry sand.

A similar chute screen is sometimes used in connection with an ordinary bucket elevator driven by a gasoline engine, which is housed in between the elevator and the gravel bins. The bins are sufficiently elevated to permit of drawing the gravel by gravity directly into the wagons, thus saving any further cost for loading. In such cases the gravel is delivered to the elevator boot by means of single horses hitched to drag scrapers. With such an outfit it is easy to screen from 60 to 75 cubic yards of gravel per day, and to keep the cost of screened gravel in the bins at from 20 cents to 25 cents per cubic yard. The force required is: Three single horses on drag scrapers, each with man; one team and man with wheel scraper to remove sand; one superintendent who acts as engineer and handy man about the plant.

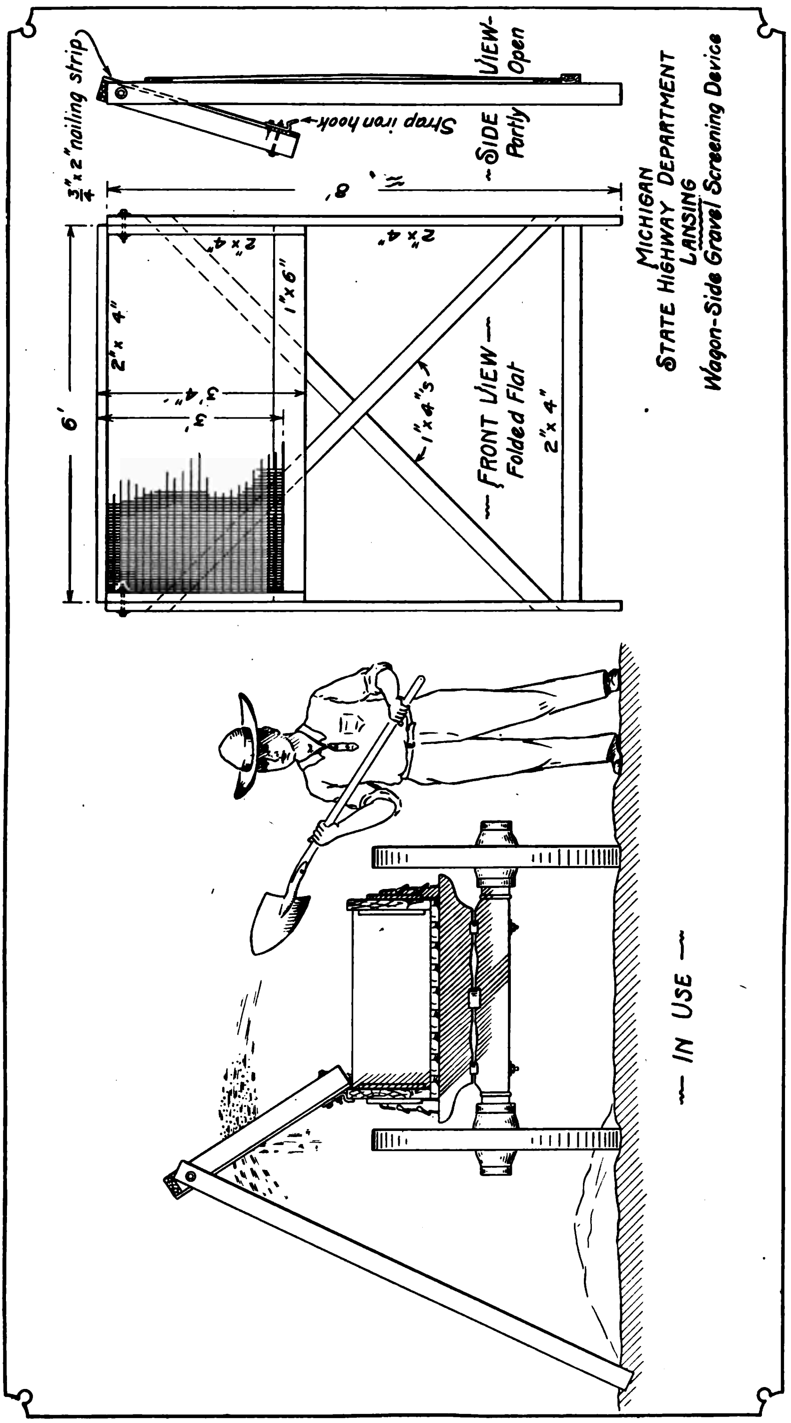
3/4"x2" nailing strip
Strap iron hook
~SIDE VIEW~
Partly Open
8'
6'
2"x4"
2"x4"
2"x4"
1"x6"
3'4"
3'
~FRONT VIEW~
Folded Flat
1"x4"s
2"x4"
MICHIGAN
STATE HIGHWAY DEPARTMENT
LANSING
Wagon-Side Gravel Screening Device
— IN USE —

Fig. 1.

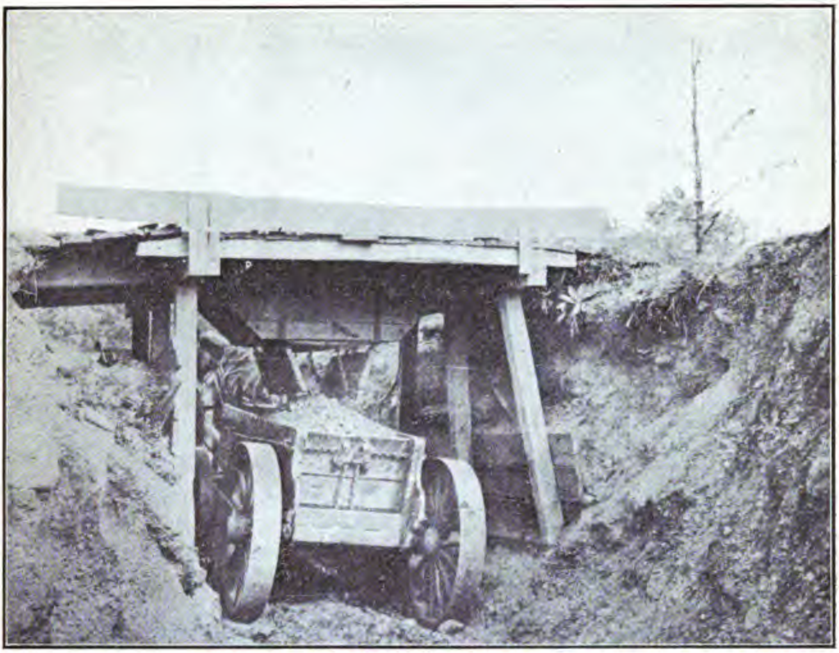

FIG. 8.
Side view of bridge gravel loader at Mentha, Van Buren Co., Mich.

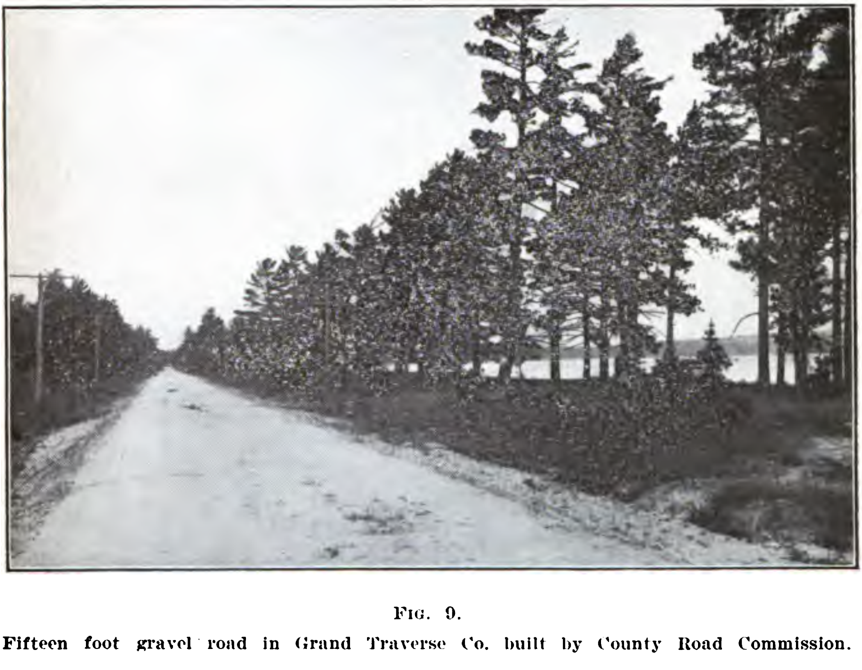

FIG. 9.
Fifteen foot gravel road in Grand Traverse Co. built by County Road Commission.

Rotary screens, already mentioned, are often used instead of the chute screen and with better results when the gravel is moist or contains any clay or loam. (See Fig. No. 6.) If much clay is present, it is impossible to screen gravel without placing a water jet in the screen, which is generally not desirable in producing road gravel. This has not been done in Michigan, except in commercial pits where most of the product is sold for concrete purposes.

Applying the Gravel.

After the road has been graded and shoulders formed as above outlined, gravel of the quality described should be put on the road in two courses and each course compacted separately.

Gravel will compact to about 80 per cent of its depth, loose measure, as applied to the road, provided it is shouldered in and not allowed to spread out and waste away on the sides. If the compacted depth is to be eight inches and the width nine feet, as required to secure state reward, it will take about 1,500 cubic yards of gravel to the mile, and it is best to make the first layer six inches deep loose measure, and the second layer four inches deep loose measure.

To reduce the amount of spreading to the minimum, it is advisable to place the gravel on the nine foot road bed by dumping two loads side by side, stringing them out just far enough to make the required depth. Thus, if two loads of gravel containing one yard each are dumped on such a road bed, they will reach twelve feet along the road and spread just six inches deep. This requires only a very little drawing out of each load at the ends. Should the teams draw one and one-half yard loads, they would reach eighteen feet down the road and spread to the same depth, necessitating moving ahead about a wagon length to dump the second half of each load. The top layer should be dumped in the same manner, bearing in mind that to spread only four inches deep the same sized loads will reach a half farther, making two one yard loads reach 18 feet and two one and one-half yard loads reach 27 feet. The distance two loads should reach is best gaged by setting little stakes the proper distance apart in the shoulders along the margin of the gravel bed. These stakes can be moved ahead as the work progresses.

Harrowing and Rolling.

Usually the gravel should be placed on the road commencing at the end of the road nearest the gravel supply so that the teams will aid in packing. As soon as thirty or forty rods of gravel have been spread on the road it should be harrowed with a spike tooth harrow, preferably one of the lever type. If but few teams are hauling, the harrow may be used twice daily, just before quitting time at noon and again at night. If a hundred yards or so of gravel are hauled to the road daily, one team should be working on the harrow all the time. The harrowing should be done the same for both courses. As soon as the gravel has been well wet by rains it should be rolled with the best roller available. For this purpose a weighted field roller may be used if one can be had that is strong enough to bear weighting to three or more tons. A heavier roller of larger diameter is preferable, and where possible it is better to use a regular road roller, either of concrete or cast iron, weighing not less than four tons. In some places such rollers have been hauled with traction engines, the engine wheels doing as much or more compacting than the roller. Where a power roller is obtainable, it is better and more efficient than any of the others. The concrete roller is shown in Figure No. 2.

Each course should be rolled separately, commencing at the sides, rolling lengthwise of the road, but gradually working towards the center. In the final rolling the whole surface of the roadway, including the shoulders, should be rolled and left in such perfect condition that water will flow without obstruction to the side ditches. The grader or float may have to be used at times to preserve the crown, but the harrow should be kept running until the rolling is completed, or until the gravel becomes so well compacted that the teeth refuse to penetrate the surface.

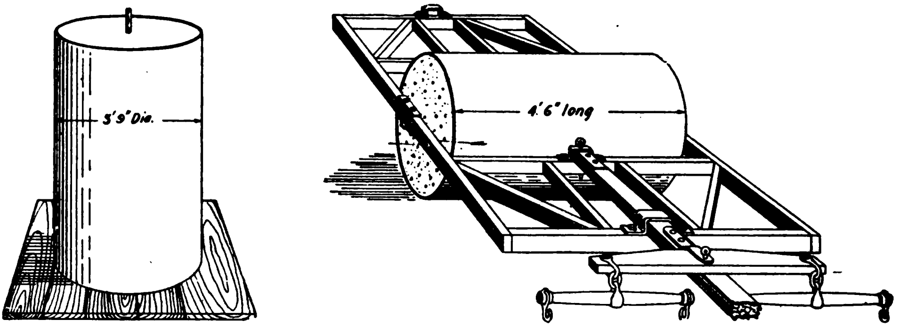

Fig. 2.

Roads built in the thorough manner above outlined are good enough to draw a state reward as provided under class B, Section 10 of Chapter V, Public Acts of 1909, as amended, which reads as follows: "Every mile of well graded road on which the steepest incline shall not exceed six percentum, except where found impracticable and a steeper grade is recommended after examination by the State highway commissioner, and the width of which shall not be less than twenty feet between side ditches, and which shall be properly drained, and have a wagon way or travel track not less than nine feet wide and which shall consist of not less than eight inches of compacted gravel, or not less than twelve inches of compacted burnt shale, which must be applied in not less than two layers, each layer to be rolled separately: Provided, That both shoulders and metaled track shall be properly crowned so as to shed water quickly to the side ditches, shall merit, if approved by the State highway commissioner, a reward from the State of five hundred dollars, and pro rata for extra miles and fractions thereof in excess of the first mile, with an extra fifty dollars per mile for each additional foot in width of metaled surface in excess of nine feet up to and including sixteen feet."

If such roads are a part of the trunk line system, provided in Act 334 of the Public Acts of 1913, the reward will be double the amounts above given.

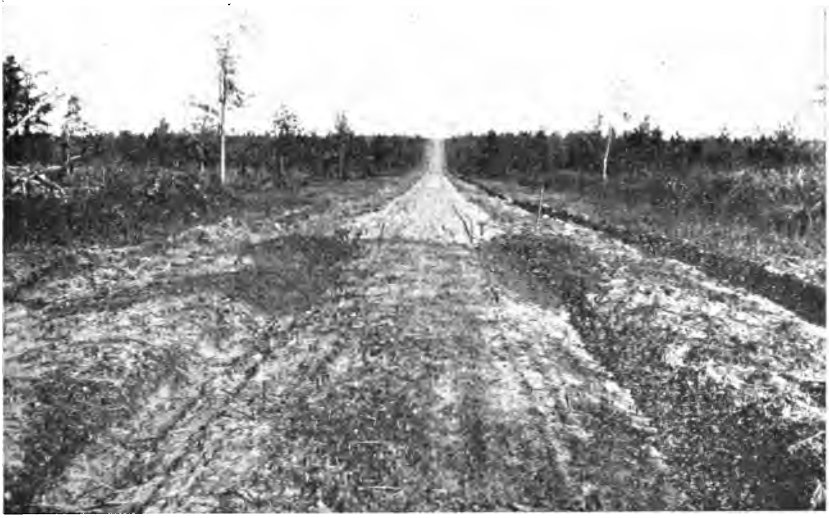

Fig. 10.

In the foreground is seen shoulders and bed completed ready to receive gravel and in the distance the first course of gravel placed.

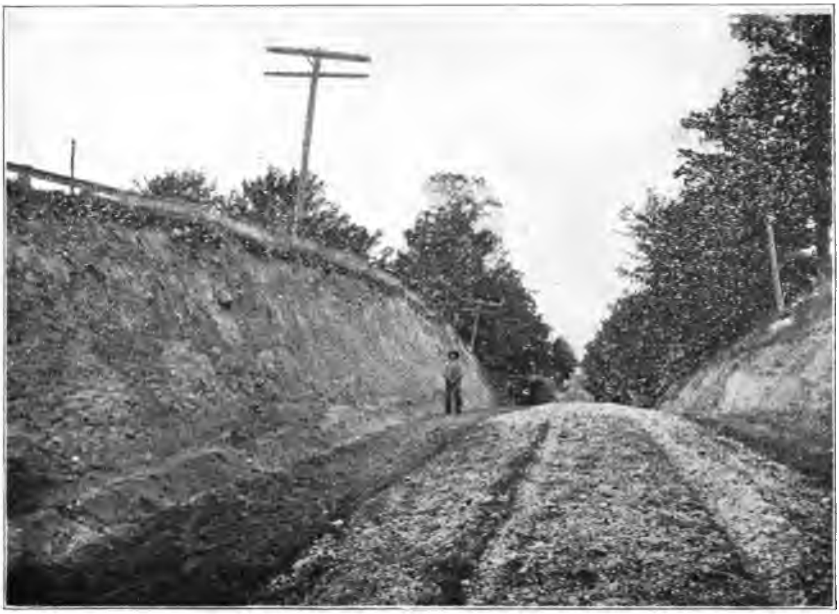

Fig. 11.

Cut in gravel road in which the sides are not sloping enough to stand against rain and frost. Slope should be 1½ to 1. An excellent quality of gravel used. Not yet compacted.

Maintenance.

To maintain a gravel road surface properly, it should have constant attention, the repairs commencing as soon as the road is opened to travel. These repairs will be considered under three heads, viz.: (1) Suitable dragging. (2) Patching. (3) Resurfacing.

Dragging.

Gravel roads are never hard enough and smooth enough when opened to travel to prevent almost immediate rutting by the wheels of heavily loaded wagons. In fact a gravel which contains enough clay to pack immediately under the roller, or in a few days under travel will always prove to be a muddy road when the frost is going out in the spring, and in prolonged wet spells at other seasons of the year. If such gravels are found on a road they can be greatly improved by covering with a thin layer of sandy gravel, applied when the old gravel is soft and allowed to mix under travel, the road being kept smooth by the frequent use of the road drag.

On any gravel road, dragging with a suitable road drag should begin after the first good rain following the completion of the road and be continued after each subsequent rain until the road surface becomes so hard and smooth that heavily loaded wagons make no impression on the road surface. This means that the dragging must be frequent the first fall until winter sets in, and the following spring until the middle of May or the first of June. After that, the dragging will not be very effective, unless the rains are of long enough duration to slightly soften the surface, and may, therefore, be less frequent. But dragging will still be found very effective and efficient in the late fall and in the spring, when the frost is coming out and before the gravel is fully settled.

The plank drag, the log drag, or the various forms of steel drags will be satisfactory for this work. When wooden drags are used, they should be faced with some kind of steel plates. Plans for a plank drag or float are shown in Figure No. 3.

When this dragging is systematically followed up, it will be found that the cost of maintenance of gravel roads, even with some patching, can be kept below $10.00 per mile a year.

Patching.

This work is usually neglected or done in such a way as to cause two ruts to form where there was but one before. That is the invariable result of filling a rut too full. This work should always be done when the road is wet, preferably when the water is still standing in every little hollow on the road surface, so that the workmen can see just where to place the new gravel and about how much is required.

Unless the rut is a very large one, it is always best to shovel the gravel from the wagon into it, rather than to raise a side-board and attempt to dump a part of the load.

Patching done in the proper manner when the road is wet, followed by the road drag, will maintain an old gravel road surface as good as new until it is so badly worn that an entirely new surface is required. The gravel used should never be poorer than that forming the surface layer of the old road, and espeially should not contain an excess of clay. The best results will be obtained by using the same kind of gravel as was used to build the old road.

This kind of patching should never be done when the old road bed is hard and dry, for then the new material is soon ground into powder and makes dust and mud.

Resurfacing.

The work of resurfacing an old road is much the same as putting on the top layer of gravel when building a new road. If the layer is to be more than three inches thick, it will often be necessary to form slight shoulders by scraping the loose and worn material from the central portion of the road bed to the sides. Frequently, the crown has all been worn off the old road bed, and sometimes more, leaving the old road surface concave or "dishing." In such cases, the new gravel will have to be thicker in the center and "feathered" out at the edges. The new gravel can be kept in proper crown by the frequent use of the road drag, as already described, sometimes supplemented by the use of a road grader.

It should be needless to add that the best gravel obtainable ought to be used for resurfacing. It is also best to do this work in the spring or fall when the old bed is not too hard, so as to prevent any of the new gravel from being ground up under the wheels of heavily loaded wagons, especially if any part of the new layer is less than three inches thick.

The gutters and ditches must at all times be kept clear of dirt, rubbish, weeds and brush so that the water always has a free and unobstructed flow to the nearest drains which can remove it permanently from the road.

Mileage and Cost.

Not more than eight thousand miles, or approximately one-ninth of the total road mileage of Michigan, have been reported as surfaced with gravel. Some of these are very good and some scarcely better than common earth roads. This is caused, first, by placing gravel on improperly graded and undrained roads and, second, by using gravel which contains too much sand or too much loamy clay.

Since the state reward road law became operative, there have been built about 1,000 miles of gravel road which have received a state bounty. These roads have ranged in cost from a little less than $1,000 upwards to $3,000 per mile, the average being not far from $1,800.

Gravel roads are popular in Michigan for the following reasons:

(1) Because they are durable and satisfactory.

(2) Because they are easily built and easily repaired, requiring no expensive machinery.

(3) Because the first cost is low.

(4) Because they draw a relatively large state reward, frequently one-third or more of their cost.

(5) Because they are a labor proposition from start to finish and keep all the money spent in their construction at home.

If you have good gravel, build a gravel road.

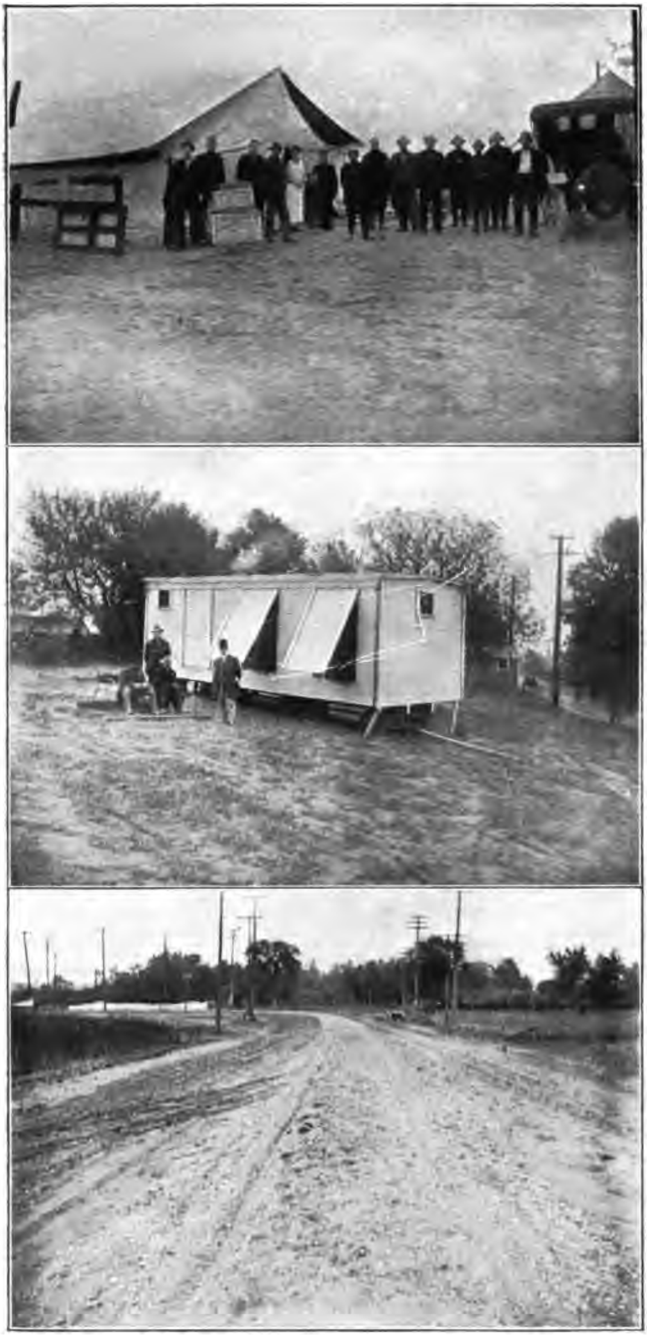

FIG. 12.
Kalamazoo County road camp. Middle picture shows "prisoner's van" in which the county keeps prisoners at night. Lower picture shows finished (partly compacted) gravel road built in this county.

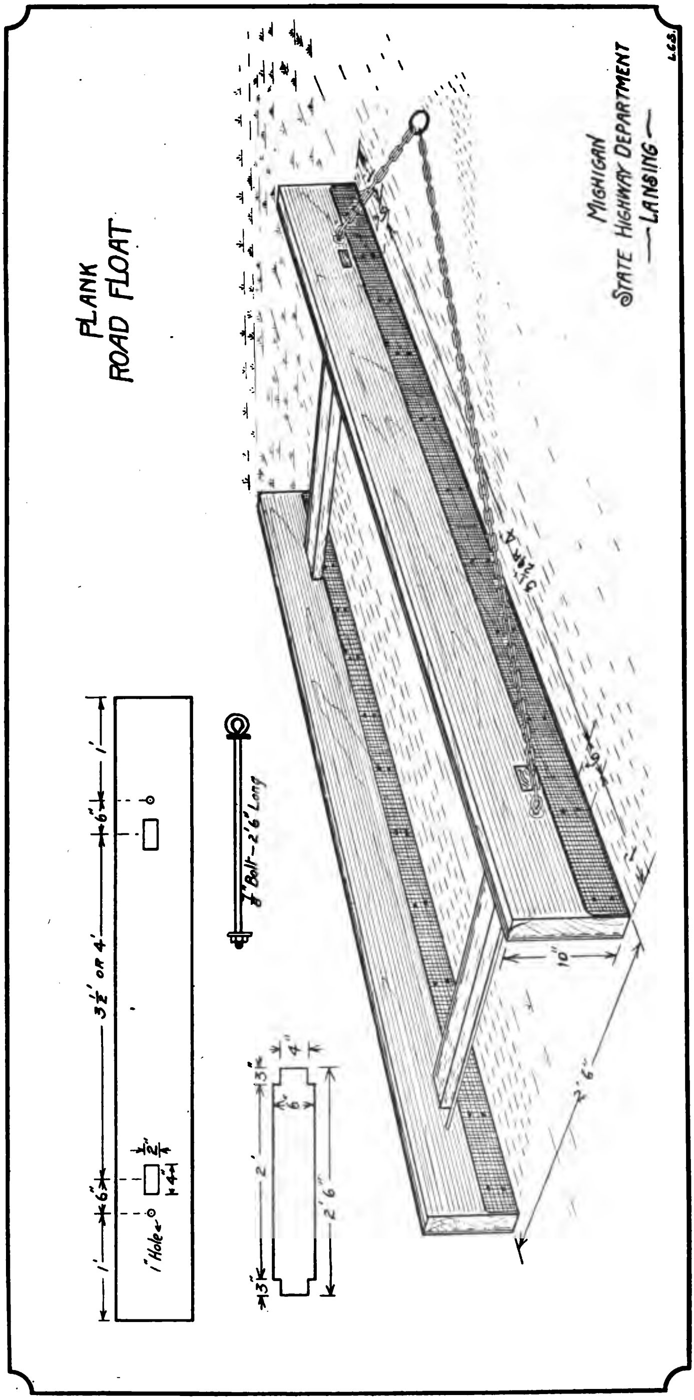
PLANK
ROAD FLOAT
1'
6"
3½' or 4'
6"
1'
1" Hole
½"
4"
¾" Bolt - 2'6" Long
3"
4"
6"
2'
2'6"
3"
3½' to 4'
6"
2"
10"
2'6"
MICHIGAN
STATE HIGHWAY DEPARTMENT
—LANSING—
L.C.S.

Fig. No. 3.

GENERAL SPECIFICATIONS FOR GRAVEL ROADS—CLASS B.

Section 10, Chapter V, Act No. 283, Public Acts 1909 as amended.

If the work is to be done by contract, write the State Highway Department for blank forms for bids, contracts and bonds. They will be furnished without charge.

Grading.—The roadway shall be graded so as to strictly conform to the plans and specifications for the road in question, heretofore submitted to and approved by the State Highway Commissioner. The furnished road shall be not less than twenty feet between and exclusive of side ditches or gutters and have a cross-section oval in form, with an average rise of one inch to the foot from the inner edge of such ditch or gutter to the center line of the road. Twenty feet is too narrow for the roadways of heavily traveled roads, and the State Highway Department recommends that turnpikes be made from twenty-two to twenty-four feet wide where the travel is heavy. In general, earth for fills should be taken from cuts. In no case shall deep unsightly ditches be cut along the roadside for the purpose of making fills. For more details as to the manner of forming grades and ditches see cut Figure No. 13.

Drainage.—The side ditches and gutters shall be of such size as the drainage requirements of the locality demand and must be formed with true grades, having sufficient incline to furnish a free and uniform flow of water to the nearest natural outlets, which outlets must be so improved, where necessary, as to carry the water quickly away from the highway. The slope of the banks of ditches shall be not steeper than one and one-half horizontal to one vertical.

Tile drains shall be laid where needed at such places and of such kind and size and on such grades as may be shown on the plans.

In clay soils trenches shall be cut through the shoulders described in the next paragraph, making outlets into the side ditches for water that may collect in the gravel bed during construction and later before the surface becomes hard and water proof. Such trenches shall be eight inches or more in width and slightly deeper than the gravel bed. They shall be placed at all low points in the grade and not farther than one hundred feet apart in retentive soils and filled with coarse gravel when the first layer of gravel is being applied.

Gravel Bed and Shoulders.—After the road has been graded as above described the gravel bed shall be formed in the central part of the road grade as follows: Shoulders of firm earth or other suitable material shall be placed on each side of the gravel bed not less than nine feet apart or such greater distance as may be required to retain the width of gravel specified. The shoulders shall extend to the side ditches or gutters at the same grade and curvature as required for the finished road. Where the road grade is high the shoulders may be formed by moving earth from the center of the present road grade to the sides or, if the grade is low, by crowning the present road grade by scraping earth from the sides toward the center, or, if sufficient suitable material cannot be had along the roadway, it shall be brought from other places along the line of work.

Rolling Sub-grade.—After the shoulders and gravel bed have been formed as above described the whole roadway shall be rolled until no more compacting is possible. The hollows developed by this rolling shall be filled with suitable material under the direction of the officers in charge and the roadway again rolled and left in solid and firm condition everywhere parallel to the finished roadway, the metal bed being eight inches below the finished grade and having the same crown. In deep mealy sand, where rolling is impracticable when subgrade is shaped, marsh hay, wet straw or fine brush shall be laid on subgrade to prevent the first course of gravel from mixing with the sand.

First Course of Gravel.—After the road has been graded and rolled in the manner above described, a layer of gravel shall be spread on the prepared bed to such uniform thickness as to be not less than five inches deep after compacting, six inches deep, loose measure. The gravel for this course shall consist of good, clean bank gravel, not less than sixty per cent by weight, a larger per cent if possible, of which shall be pebbles that will be retained on a screen of one-eighth inch mesh and pass through a screen of two and one-half inch mesh. If clay gravel is used, it should contain only clay enough to coat the pebbles, no free lumps. In no case should the clay exceed ten per cent of the mass, for clay makes mud and adds no wearing qualities. The gravel course shall then be harrowed with a spike tooth harrow and rolled until no further compacting is possible. The rolling must be done only when the road has been well wetted by sprinkling or after rains. Any hollows that may develop in the gravel during the process of rolling shall be filled with the same kind of gravel and the rolling continued until the surface is uniformly smooth and hard and everywhere parallel to and three inches below the surface of the finished road. The crown can be preserved during construction by the occasional use of the grader or other suitable floating tools. Ruts formed by hauling over the gravel shall be kept filled by using the harrow twice or more every day, preferably just before quitting time both noon and night.

Second Course of Gravel.—The gravel for the second course shall consist of good, clean bank gravel, sixty per cent by weight, a larger per cent if possible, of which shall be pebbles that will be retained on a screen of one-eighth inch mesh and will pass through a screen of one and one-half inch mesh. Other requirements for gravel in this course are the same as specified for gravel in the first course. This gravel shall be spread on the road to such uniform thickness as to be not less than three inches deep after compacting, four inches loose measure, after which it shall be harrowed and rolled in the same manner as prescribed for the first course. Any depressions that may be formed during the rolling shall be filled with the kind of gravel prescribed for the second course and the road re-rolled until the surface is uniformly smooth and hard and everywhere conforms to the proposed grade and cross-section of the road.

Manner of Rolling.—Rolling shall be done only when the gravel has been thoroughly wetted by sprinkling or recent rains, and shall at all times begin at the sides, rolling lengthwise of the road, but gradually working toward the center. In the final rolling the whole surface of the roadway, including the shoulders, shall be rolled from ditch to ditch and the whole road grade left in such perfect condition that water will flow without obstruction to the side ditches. Rolling may be done with a power roller, a heavy horse roller or a traction engine followed by a weighted field roller, if one of suitable strength to bear weighting to three or more tons can be obtained.

With any kind of a roller the spike-tooth harrow, preferably of the lever type, should be used as long as the teeth will penetrate the surface.

Approved July 1st, 1913.